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CONTRIBUTIONS

TO THE

GEOLOGY AND THE PHYSICAL GEOGRAPHY

OF

MEXICO,

INCLUDING

A GEOLOGICAL AND TOPOGRAPHICAL MAP,

WITH PROFILES,

Of some of the principal Mining Districts;

TOGETHER WITH A GRAPHIC DESCRIPTION OF AN ASCENT

OF

THE VOLCANO POPOCATEPETL.

EDITED BY

BARON F. W. VON EGLOFFSTEIN.

NEW YORK:
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Entered, according to Act of Congress, in the year 1864, by

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INTRODUCTION.

The general interest excited, on this continent, as well as in Europe, by late political events in Mexico—where a wide field for mining and land-speculation is about to be opened again to foreign industry and foreign capital—has induced me to submit to the public two interesting publications, made many years ago, describing the *geological formations* of the *mining districts*, and the *physical geography* of this highly-favored region.

It is well known, that the physical construction of Mexico differs, wholly, from that of the great neighboring country, in the adjacent portions of North America, and presents, by the high elevations of the table lands, and the variety of climate and production, many important features for the further investigation of the natural sciences, and for industrial enterprises—particularly, for the extraction of the precious metals, and the growth of all agricultural products, both of the tropical and temperate regions.

The publications alluded to, are: 1. A geological map, with profiles, showing the general formations of rocks, in which most of the mineral wealth of Mexico is deposited—published by two eminent mineralogists, Frederick von Gerolt and Charles de Berghes, who were enabled to collect, during their extensive travels in that country, valuable scientific materials, by personal observations, and from other sources, principally obtained in the several mining districts which they visited.

The topographical map was compiled by CHARLES DE BERGHES.

The geological observations and profiles, were made by FREDERICK VON GEROLT, who, at the suggestion of ALEXANDER VON HUMBOLDT, and other scientific gentlemen, published the map (with the profiles), in *three sheets*, accompanied by the subjoined description.

These original charts are reduced in the present publication, to a smaller scale, and condensed on *one sheet*, including the geological sections, in full.

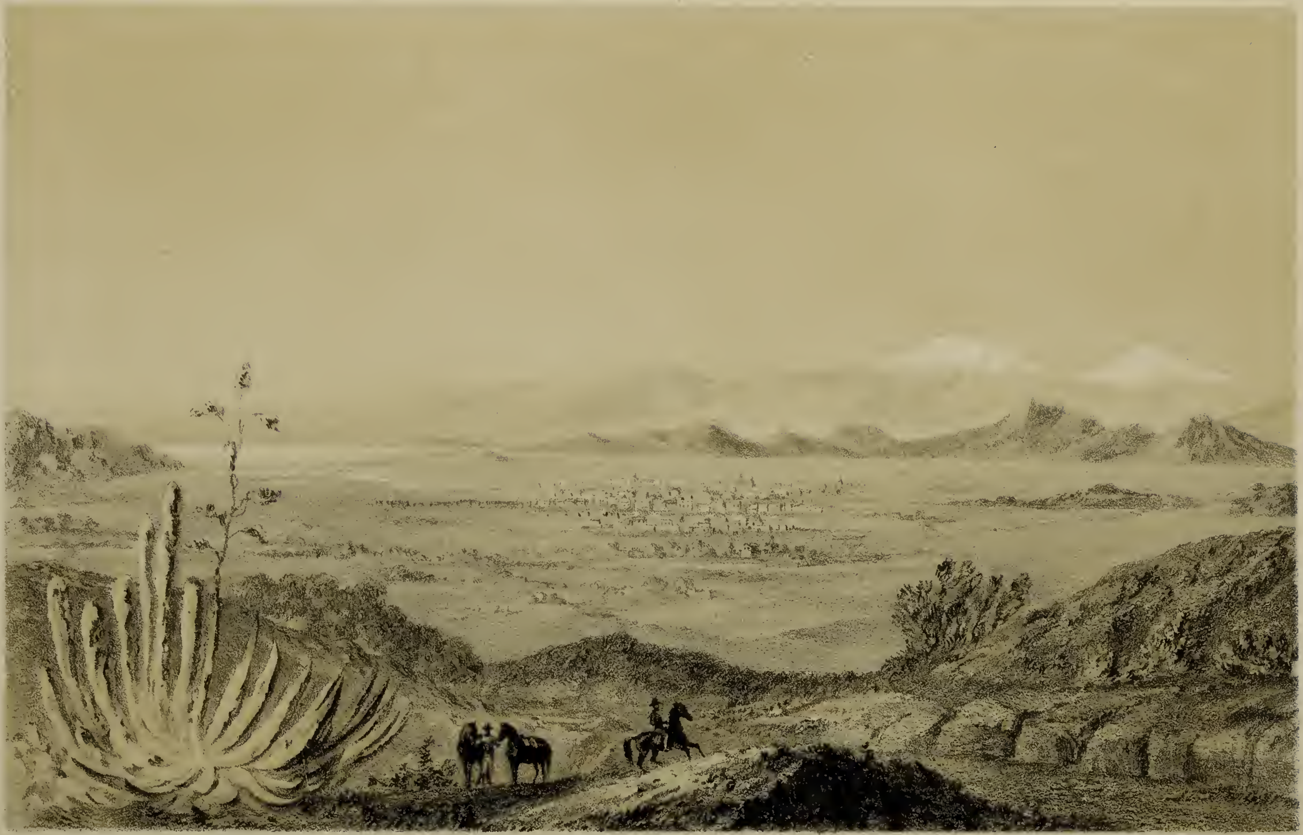
Some pictorial views of the *Valley of Mexico*, copied from original landscapes, in oil colors, by the celebrated artist and traveller, RUGENDAS, will be found in the letter-press.

2. The additional part of the present publication, is connected with the first-mentioned work, as an appendix to the *Geology* and the *Physical Geography* of Mexico, presenting a translation of the report of F. VON GEROLT, of two expeditions, made in 1833 and 1834, by himself and Baron L. GROS, of the *ascent of the Volcano Popocatepetl*, near the City of Mexico.

This description was transmitted to ALEX. VON HUMBOLDT, by whom it was published, in "*Erdmann's Annalen der Erd-Voelker-und Staatenkunde*," at Berlin, in 1835.

BARON F. W. VON EGLOFFSTEIN.

New York, June 15*th*, 1864.



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VALLEY AND CITY OF MEXICO.

PART I.

EXPLANATORY REMARKS UPON THE ACCOMPANYING MAP AND PROFILES,

BY FREDERICK VON GEROLT.

THE object in view, in the preparation of the present geological map—which was constructed from *observations* and *detail surveys*, made upon the ground—is, principally, to direct attention to the many important formations of metalliferous rocks, containing, in their bosoms, untold treasures of the precious metals.

The geographical positions are based upon results of observations made by Alexander von Humboldt, whose map of the *Valley of Mexico*, has been incorporated; and the present delineation is extended upon the same scale.

The first Meridian for Longitudes, passes through the city of Mexico. Additional geographical determinations, as well as geodetic observations, were made, with the theodolite and box-sextant, locating the main *chains* of *mountains* and the *principal rivers*.

Where their configurations remain unknown, the word *Cerranía*—in English, *mountainous region*—has been inserted.

The various routes and lines of profiles, were surveyed by means of the pocket compass, and the altitudes were ascertained by English mountain barometers, wherever geological observations were made; and from these, the latter have been constructed.

The distances used in constructing the horizontal base of the profiles, correspond with those of the map.

The vertical distances have been distorted fifteen times.

These sections, or profiles, do not always follow air lines, but show, for the most part, the topography of the roads on which I travelled during the various journeys.

The greater part of the surface comprised within the limits of this map, and tinted in red, is composed of volcanic rocks, or such formations as are regarded by modern geologists as having been formed by direct, or indirect, volcanic action.

These formations embrace a great variety of non-metalliferous porphyries, trachites, phonolites, basalts, pearlstone, obsidian, pumicestone, volcanic conglomerate and tufa; and, further, a great number of extinct craters, &c., &c., which are specified upon the profiles.

A remarkable feature in this group is presented by the deposits of pumicestone, of vast extent, at *Huichapa* (lat. 20° 19′ N., long. 0° 33′ W.),* where the latter is extracted by subterraneous mining; further, the presence of obsidian in the *Cerro de las Nabajas*, near Regla, and the existence of fire-opal and milk-white opal, near *Zimapan* (lat. 20° 44′ N., long. 0° 21′ W.), in small lodes, in a reddish trachyte, free from feldspathic crystals, superposing the non-metalliferous porphyry.

Hyalithe, zeolithe, calcareous spar, arragonite, mesotype, &c., &c., are frequently found in these porphyries.

Intimate relations exist between the metalliferous and non-metalliferous porphyries. The metalliferous porphyry is less frequent, but constitutes the most important formation, bearing the precious metals, and is marked in a lemon yellow color upon the map, embracing the rich lodes of *Real-del-Monte*, *Pachuca*, *Chico*, *Capula*, and *Santa-Rosa*, all of great richness and magnitude. They further form the mineral districts of *Angangueo*, *Oro*, *Huautla*, &c., &c., and part of the mountains of *Zimapan* and *Istapa-del-Oro.*

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* Longitudes and latitudes are here stated approximately, to facilitate the reader in finding the locality upon the map.

The lodes found in this porphyry are characterized by their magnitude, and the consistency of the ores they contain. Besides the many nests of rich silver ores, the body of the lode is, more or less, impregnated with the the same metal.

The existence of such large lodes, containing an almost equal percentage of silver ores, allow reliable calculations to be made as regards the extraction of silver; and the great profits derived from these mining operations, do not exclude the hope of finding numerous other nests of rich ore.

The running lode in the mine of *Arevalo*, at *Atotonilco-el-Chico*, has a width of, from thirty to fifty feet, with a southerly dip and a westerly direction.

The crest of this lode can be traced for several miles towards the West.

In the district of *Santa-Rosa*, five leagues to the westward of *Chico*, the same lode is worked, under the name of *San Eugenio.* From here, this lode continues through the body of the high rocky range, called *Los Organos*, and is covered with volcanic rocks, in the valley of Actopan. The body of the same at Chico, consists principally of calcareous spar; in Santa-Rosa, it is principally quartz, containing silver ores, namely, sulphuret of silver and argentiferous pyrites.

Many smaller lodes to the North of that of "Arevalo," contain also sulphuret of lead and sulphuret of zinc.

The richest ores of native silver, sulphuret, chloride and oxide of silver, are found in the lodes of *Real-del-Monte*, *Pachuca*, and *Santa-Rosa.*

In *Zimapan*, the lodes contained in porphyry, bear much calcareous spar and fluor spar, with sulphuret of lead, sulphuret of iron, sulphuret of copper, and sulphuret of arsenic, all containing silver, as well as sulphuret of silver and oxide of silver.

The width of the lodes in this district, varies from two to four feet.

In *Angangueo*, the mass of the lodes consists of silver-bearing sulphuret of arsenic, with sulphuret of lead, some blende and rich ores of sulphuretted antimonial silver, and also native silver. Direction almost South.

In *Huautla*, the mass of the lode is found to be a species of porphyry, resembling the rock in which it is embedded, and some quartz, with sulphuret of silver, disseminated very finely; also oxide of silver and native silver.

Many lodes found in porphyry are gold bearing, as, for instance, at *Santa-Rosa*, *Pachuca*, *Oro and Istapa-del-Oro.*

Gold is found *pure*, with the accompanying pyritical silver ores, apparently only in the upper parts of the lodes.

In *Istapa-del-Oro* (lat. 19° 8′ N., long. 1° 13′ W.), and in *Tetela-Xonotla*, forty-five leagues from Mexico, in an E. N. E. direction, pure gold is found deposited in the drift, constituting the surface of the ground, where it is washed out by the inhabitants. The gold seems to exist in small particles, in the metamorphic *porphyry mountains*, whence it is carried, by the rains, to the valley, as the rocks become disintegrated by the atmosphere.

Near Zimapan, below the *Hacienda de Toliman*, narrow lodes of alum are found in the porphyry. Trachites occur frequently, but I have never found metalliferous lodes in this porphyry.

The richness of the precious metals contained in this formation, is the only characteristic which establishes for it the claim to a distinct classification, as neither the relative position, nor the petrographic character would warrant a distinction; the general aspect being similar to that of the bordering non-metalliferous porphyries, which partly cover this formation.

One circumstance, however, is remarkable: that with the metalliferous porphyries, in their body as well as in the crystals, feldspar is the great characteristic; while with the non-metalliferous porphyries, vitreous feldspar is prevalent.

A stratification of the porphyries, I have never been able to discern; and what might lead to be taken as such, has more the appearance of the cleavage.

After carefully examining the metalliferous and the non-metalliferous porphyries, it is apparent that, probably, both belong to the same original formation, which, however, has been much affected by volcanic action, destroying and changing the former; and, further, it is clear that the metalliferous porphyries of to-day, are but the small remnants of the mass, as it existed in its primitive state, and which has remained unchanged during the volcanic revolutions. The predominance of common feldspar speaks in favor of this supposition.

As regards the relations of the porphyries and the Silurian slates, I have invariably found the latter superposed by the porphyries; particularly,

1. In the valley *Baranca de Toliman*, three-quarters of a league distant, and North of *Zimapan*, where also several lodes of trachyte traverse the slate formations, without penetrating the superposing porphyries. (See profile No. 4.)

2. In the valley of the *Rio Ixtoluca*, at the point where the road from the works of the same name, branches off towards the mining district of *Huautla*. (See profile No. 8.)

3. In the valley of the *Rio Montezuma*, at *Puente-de-la-Seja*, six leagues South of Zimapan. (See profile No. 3.)

4. In the deep valley, *Baranca de Malinaltenango*, two leagues Northeast of Zacualpan. (See profile No. 7.) I have not seen one instance of slate superposing the porphyries.

The slate formation, is covered by stratas of porphyry and other volcanic formations; it does not extend to the higher summits of the mountains, yet forms, from all observations, the base of the plateaus of Mexico. It deserves, from its great variety of mineral lodes, the special attention of geologists and mineralogists.

The slate formations are indicated upon the map, in a blue color, forming, with their many branches, the mining districts, and were known at an early age, as for instance, *Tlalpujahua*, *Temescaltepec*, *Sultepec*, and *Cristo;* these being all in argillaceous slate; at *Zacualpan*, varying in the argillaceous gray wacke and the green stone slate; at *Zimapan* and *Pechuga*, in calcareous slate and silicious slate; at *Cardonal*, in calcareous slate, with limestone; and at *Istapa-del-Oro*, the operations are carried on upon argillaceous slate, and upon stratas of limestone.

The dip of the stratas of slate takes place from South to West, but at *Temascaltepec* and *Tasco*, they vary from this direction, being here from East to Northeast.

The lodes of the slate formation are, on an average, much smaller than those in the porphyry; neither are the precious metals so continuous; but they contain the richest beds, principally of pure silver, sulphuretted antimonial silver, and sulphuret of silver; and many of these lodes have a large percentage of gold, as, for instance, at Tlalpujahua.

Besides the innumerable lodes of ores contained in the slate formation, the same bears also many others impregnated with the precious metals. These are found in the mining district *La Pechuga* (lat. 20° 43′ N., long. 0° 7′ W.), in the calcareous slate. Mineral lodes, of, from one to six feet in thickness, are plainly visible, consisting, for the most part, of calcareous spar, disseminated with sulphuret of silver and native silver. Many lodes also contain white-lead ores.

In one ravine, the mine of *Zapote*, I found *granite* embedded in *calcareous slate.*

A similar occurrence is presented by the presence of granite in argillaceous slate, at *Cristo* (lat. 18° 44′ N., long. 1° 4′ W.), in the valleys of the *Rio Salitre* and the *Rio Juluapa.* Another lode of silver ores is found in the district of *Tetela-Xonotla*, in the State of *Vera-Cruz*, about forty-five leagues E. N. E. of Mexico, where, in the limestone formation of the *Silurian-Epoch* are found extensive stratas of calcareous spar and compact silicious magnesia, of a white and reddish color (*maganèse carbonaté blanc*), interspersed with sulphuretted silver and large *nests* of *pure gold*, especially in the mine of *Espejeras*, where the lode reaches a thickness of over eighty feet.

The same slate formation contains, in the mining districts of *Cardonal* (lat. 20° 36′ N., long. 0° 4′ E.), and at *Zimapan* (lat. 20° 40′ N., long. 0°20′ W.), many large lodes of lead ore, diprismatic lead spar and lead glance, and at *Tejupilco* (lat. 18° 55′ N., long. 0° 58′ W.), lodes of gray sulphuret of antimony. Lodes of copper and sulphurets, as well as lead glance, are also repeatedly seen.

The presence of *quicksilver*, which is found at *Cadereïta* (lat. 20° 37′ N., long. 0° 41′ W.), I had no opportunity to examine.

A third formation, is that of the *limestone* and *syenite*, constituting the mineral district of *San José-del-Oro* (lat. 21° N., long. 0° 5′ W.), and indicated in gray upon the map.

This formation consists of granular limestone, of a dark gray color, changing into snow-white, and of a fine granular syenite of white feldspar and hornblende, without any foreign properties.

Both stratas vary in position, and form the highest mountains, of, from 9000 to 10000 feet (English), above the level of the sea.

On the road from Zimapan to San José-del-Oro, laid down on profile No. 2, the *slate formation* is crossed at right angles; consisting here of stratas of alternating calcareous slate and silicious slate, with a dip towards the Southwest, but at *Campo-Santo*, resting horizontally upon the limestone and syenite formations.

This formation, therefore, must be of a higher age than the *Silurian*, and appears not less important, owing to the presence of the lodes of precious metals.

Among the metalliferous lodes, those contained in the *garnet-rocks* are interesting, and merit particular attention. In these are met small lodes of copper, and also fragments of copper and iron pyrites, with *verdigris* disseminated with *gold.*

The mass of the garnet rocks is also frequently impregnated with *native gold.*

The mining operations for extracting the latter, were formerly of great extent and importance.

In like manner, as the lodes of the garnet rocks, are found in the limestone and syenite formations, so, too, extensive deposits of *magnetic iron ore* are traced.

Rich lodes, of, from three to five feet wide, containing diprismatic leadspar, and lead glance, copper ore, and a considerable percentage of *silver* and *gold* are found, principally, in the mine of *Chalma.* The direction of the same is towards the West; the dip towards the South. Various lodes of copper and iron pyrites are also found here.

The limestone and syenite formations have, as yet, been but little examined; and in that region, so sparsely settled, surely only the smaller number of mines has been discovered. I have never found the volcanic formations superposing the limestone, or syenite.

A more rare formation is that of a *compact gray limestone*, differing in position from the transition limestone.

The latter makes its appearance in many localities, as, for instance, at *Cardonal*, on the road to *Actopan*, at *Tlaltizapan* and *Tlalquiltenango* (lat. 18° 34′ N., long. 0° 2′ W.), as represented on profile No. 5; at *Istapa-del-Oro* (lat. 19° 7′ N., long. 1° 15′ W.), and at *Tetela-Xonotla*, in connection with, and forming part of, the slate formation, alternating with calcareous slate and argillaceous slate—assuming the character of the latter.

The compact limestone, however, found at *Istapa* (lat. 18° 56′ N., long. 0° 22′ W.), at *Regla* and *Atotonilco-el-grande* (lat. 20° 17½′ N., long. 0° 37′ E.), and marked in dark gray upon the map, seems to belong to the mountain limestone; which is found little extended, with no regular stratification, and without contact with, or relating to, the transition slates of the same geological period. It is generally admitted that the transition limestone often changes into calcareous slate, which is not the case with this mountain limestone.

The presence of hot springs (sulphuric containing natron) is also characteristic of this limestone; but the existence of metalliferous lodes in it, I have not been able to discover during my observations.

Conglomerates are very far extended; principally those composed of volcanic remains, loosely cemented by the original tufa, which often appears calcareous, covering entire sections of the country. As apparent in the *Valley of Mexico*, on the road to *Tula* (lat. 19° 58′ N., long. 0° 15′ W.), at *Huichapa*, *Tecosaucla*, *Zimapan*, and *Actopan*, in the region of *Cuernavaca* (lat. 18° 54′

N., long. 0° 2′ W.), in the *Valley of Toluca* (lat. 19° 16′ N., long. 0° 17½′ W.), &c., &c.

Conglomerates of fragments of *transition rocks* are generally found superposing the *Silurian*, often forming *breccias*, as, for instance, near Zimapan.

Calcareous tufa is also found, in many places, but within narrow limits, and near to the limestone formations.

Many extinct volcanoes in the *Valley of Mexico*, in the *Valley of Toluca*, and at *Cuernavaca*, at *Cristo*, &c., offer, besides the ordinary features of volcanic sand and tufa, with conglomerates—composed of fragments of vitreous porphyries, pumicestone, black and red lava, &c.—scarcely any other interesting feature to invite the attention of the oryktonogist and geologist.

These volcanoes remain, as it were, witnesses to the great and manifold revolutions which have since changed the surface of the globe.*

Little as the foregoing description of the geological structure of this region presents, it is intended to furnish to the reader an *outline of this section of Mexico*, which can safely be trusted to form, in conjunction with the accompanying map, a reliable base upon which to record future observations, or to correct the errors that may exist in the sketch.

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* The highest of these volcanoes, the *Volcano of Popocatepetl*, was first ascended, from the city of Mexico side, by two Englishmen, *William* and *Frederick Glennie*, officers of the UNITED MEXICAN COMPANY (mining company).

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POPOCATEPETL. IZTLACCIHUATL.

PART II.

OBSERVATIONS MADE ON TWO EXCURSIONS FROM THE CITY OF MÉXICO TO THE POPOCATEPETL, IN 1833 AND 1834, BY FREDERICK VON GEROLT.

About the end of May, 1833, when the dry soil of the highlands of Mexico — barren during six months of continuous drought, had been partly refreshed by the first heavy showers, indicating the rapidly approaching "rainy season," and creating, as if by magic, a new world of vegetation—I undertook an excursion to the *Volcan de Popocatepetl* (signifying, in the Indian language, "smoking mountain"), in company with my friend, Baron Louis Gross, then *Chargé d'Affaires* of France to this country, a distinguished landscape painter and naturalist. This volcano, which is situated at the distance of two days' journey from the capital, is, next to the peak of *Chimborazo*, the highest in America.

Provided with the following instruments, a barometer, for measuring heights, a Daniels-hygrometer, a theodolite, and two thermometers, and furnished with the necessary provisions for the expedition, we set out from the city of *Mexico*, on horseback, attended by our servants, with pack-mules, and an escort of dragoons, which the government had assigned to us for protection.

From the capital, we proceeded eight leagues Eastwardly, on the highway to *Vera-Cruz*, between the Lakes *Tezcuco* and *Chalco*.

These lakes present one of the grandest and most picturesque of natural spectacles. Their mirror-like surfaces reflect the many surrounding scattered volcanic peaks and extinguished craters of the valley of Mexico, in the rear of which extends the grotesque chain of the *Cordilleras* (forming the South-eastern boundary of the valley), with two gigantic summits, the *Popocatepetl* and *Iztlaccihuatl*—the latter signifying "white woman"—emerging from dark pine forests, and towering majestically, with their snow-capped summits, high above the clouds.

The first of these peaks is a perfect cone, and lies in an air-line, twenty leagues from the city of *Mexico* (15° N. L. and 30° E. L.) Its height, according to Alexander von Humboldt's geodetic measurement, is, 5400 metres, or 17716 English feet above the level of the sea, and 10246 English feet above Mexico.

The *Iztlaccihuatl* forms a ragged crest, nearly half a league in length, ten English miles North of the *Popocatepetl*, 15700 English feet above the sea.

The affinity and reciprocal action of these two mountains with the *clouds* is very remarkable. The greater number of the thunder-storms are formed in the secret laboratories of these heights, and I have often, when quite near, observed the storm-laden clouds proceeding thence, amidst continual claps of thunder, to discharge themselves upon the surrounding country.

During the rainy season these thunder-storms take a North-westerly course, and discharge themselves over the valley of *Mexico*. This occurs generally in the afternoon. On the opposite side of the mountain range, towards the Southern slope of the *Popocatepetl*, the floods of rain descend later in the afternoon, and upon a lower plain, called *Plan de Amilpas*. Here, at a height of from 5000 to 5400 English feet above the sea, coffee, sugar and indigo are cultivated, and most of the tropical fruits grow luxuriantly. It is remarkable that these tropical storms, though much more violent than those of Europe, and especially of Germany, have no influence whatever on the mercurial column of the barometer. Hence, the barometer in this country cannot, as in Europe, be used to foretell the weather. On the other hand, a daily and regular rise and fall in the mercurial column is observed here, which indicates a proportionate diminution and increase of the weight of the atmosphere, similar to the ebb, and the flood-tides of the sea, and which may be attributed to the same cosmical causes. A daily observation, during two years, in the middle story (*entresuelo*) of the Mining Academy, in Mexico, with an excellent instrument, made by Carry, of London, has led me to the following main results:

1. Every twenty-four hours there are two flood, and two ebb-tides in the atmosphere. Between the hours of nine and ten, in the morning, the mercury is at its highest point; from ten, it begins to sink, at first slowly, and towards noon, more rapidly, until between three and five o'clock, in the afternoon, when it reaches its lowest point. After five, the mercury rises, though inconsiderably, until about ten, at night. It falls again after this time, until four, in the morning, when it again begins to rise, and gradually reaches its highest point, at nine o'clock, A. M.

2. The difference between the highest and the lowest points attained, is greater in the day time, than that from ten, in the night, to four, in the morning. The former difference is between 2 and 3 millimetres; the latter, only from ½ to 1½ millimetres.

3. The highest stand of the mercury occurs between nine and ten, in the morning: the lowest, between three and five, in the afternoon. Hence, it follows that the normal height of the barometrical column in Mexico, is the mean between the highest and the corresponding lowest points.

By daily observations, made from May 1833, to March 1834 (inclusive), the mean of all the highest points was found to be . . . . 0.59883 metres,
and the mean of all corresponding lowest points, 0.58711 "

whence the normal height of the mercurial column for Mexico is . . . . 0.58847 metres;
21° 06 Cent., being the main temperature of the mercury, and that of the air, 19° 92 Cent.

In the subjoined Tables, are given the main points of the mercury, from month to month, as also the highest and lowest points in each month.

Having arrived one league beyond the village of Ayotla, and eight leagues from Mexico, we left the highway and rode in a Southerly direction, along the left shore of lake *Chalco*, passing through the estates *de la Compania*, *Morales*, &c., whose vast expanse was, for the most part, covered with a verdant crop of Indian corn and barley. On the uncultivated ground, rape-seed grows, as a weed, in such abundance that large tracts of land are covered with it.

Five leagues from *Ayotla*, near the water mill, called "*Miraflores*," we left the valley of Mexico, and reached the summit of the mountain range, which here forms a narrow plateau, about 800 feet higher than the city of Mexico. On this plateau the villages of *Ameca*, *Ozumba* and others, are situated, close to the Western bases of the two snow mountains. Unfathomable rocky precipices form the declivities of these mountains, and above the dark belt of the green forest, already appears a brown desert tract of sand and naked rocks, which fill the space between the limits of vegetation (about 12614 feet above the sea), and the region of perpetual snow (about 14960 feet above the level of the sea, according to Alexander von Humboldt). The summit of these mountains, mantled in dazzling white, produce a wonderful effect, in contrast with the coloring beneath. The scene was much variegated by the rays of the setting sun, and threw my artistic friend into raptures of delight. It was here, between these two volcanoes, that Cortes opened a route to reach the capital of *Anahuac.* Not less interesting to the geologist than to the artist, are the phenomena, which present themselves on the described route, and which serve to explain the formation of these Highlands.

On the highway, three leagues from Mexico, we came upon a mass of lava, called *el Peñon-viejo* the round shape and concentric stratification of which prove clearly that it must have originated from the ejection of a fluid mass out of the earth, which flowed down, equally on all sides, before it hardened.

This mass chiefly consists of a red porous lava, which in some places has passed into a compact porphyritic rock. On the whole surface of the mound are found caves, formed by ebullition, which serve as habitations for many families. A like formation to that of the *Peñon-viejo*, is the *Peñon-nuevo*, an isolated hill half a league from Mexico, on the left of the route from *Vera-Cruz*, at the foot of which hot sulphur springs rise, which are often used as medicinal baths. This *Peñon*, a name given to all isolated dome-shaped rocks, has evidently the same origin as the before described one, since the same cavities of red and black porous lava have been formed here. The greater part of the mass of which this mound is composed, must have undergone various modifications, during the eruption, for we find here, in a small space, almost every species of volcanic rock, one passing into the other. These transitions vary from red and black porous-lava, into more compact black and red masses, which collect crystals of feldspar, and form many varieties of porphyry, appearing alternately as basalt, amygdaloid, klingstone, and many species of trachytic rock. In half an hour a complete collection of specimens of abnormal rocks can be made. The hylatite, which is often found on the surface of the amygdaloid and lava, appears to be of a later formation and, perhaps, still continues to be produced.

In these two described mountains there is no trace of a crater, or of a violent eruption; they only bear the marks of a quiet upheaval of masses, more or less melted by subterranean fire, and which, by the influences of water and air, have become consolidated on the surface. Besides the formation of abnormal rocks, composing the greater part of the mountains of the highlands of Mexico, and the slopes of the Cordilleras, descending towards the coast of *Vera-Cruz*, on the Atlantic, and to *Acapulco*, on the Pacific Ocean, there are innumerable volcanoes, which have contributed in forming them; an evidence of which is the existing extinguished, and also still active craters. Near Ayotla, and on the right of the road from Mexico, I ascended one of these craters, called *Cochumac.* The upper edge of the crater is, according to my measurement with the barometer, 852 feet above the *plateau* of Mexico. The shape of it is almost circular, and about 300 feet in diameter. Its chief outlet on the lower edge lies towards the East; the inner, as well as the outer surface of the crater, is covered with a greenish-gray incompact substance, which in the fracture is earthy, and evidently stratified. It contains also grains of the same substance, which gives to the whole a porous appearance. Under the blow-pipe, this mass melts with difficulty into a blackish scoria. That this is the original stream of lava, is proved by its uniform stratification. Overflowing the crater, the stream of lava has spread around the conical mountain, and flowed down to the level plain where, under the action of the water, it seems to have served as a cement to the wide-spread volcanic conglomerate. Inside, as well as outside of the crater, are found pieces of basaltic lava, and of other abnormal rocks, similar to those before mentioned, in describing the *Peñon-nuevo.* They are firmly cemented in the lava, and can only be regarded as ejections of the crater. They cover nearly the whole valley of Mexico, appearing, partly as loose fragments, and partly as conglomerate. The latter covers, likewise, to a great extent, the mountains we travelled over, in ascending from the level plain, near the mill, *Miraflores*, through the village *Tlamanalco*, to the plateau of *Ameca.* We rarely observed the primitive formation of these mountains, composed of trachyte, basalt, and various kinds of porphyritic rock. On the soil of this conglomerate, generally thrives a vigorous vegetation. The plateau of Ameca, although well cultivated, with Indian corn and barley, has also several sterile tracts, covered with volcanic sand of basaltic hornblende, which resists disintegration. These terminate near the village of *Ozumba*, two leagues from Ameca, and seventeen leagues from the City of Mexico. From Ozumba the road descends, on the Southern slope of the mountain range, to the before-mentioned plain of Amilpas, situated 4000 feet lower, where, in a space of twenty-four leagues in length and eighteen in breadth, are situated forty-eight sugar plantations; some of them producing also coffee and indigo. These plantations yield, annually, 200,000 quintals of refined sugar, and about 25,000 puncheons of rum, the value of which at $8 per cwt. for the sugar, and $40 per puncheon for the rum, amounts to $2,800,000. Nothing is more surprising to the traveller than the varieties of climate under this zone, which vary according to the different elevations above the sea.

In a few hours we descended from the cold regions of the fir and the oak, on the heights of Ozumba, to a hot climate, *tierra caliente*, where we found the most luxuriant vegetation, passing in that short time through successive changes of the most diversified species of trees, plants, birds and insects. In order to experience the same, or similar changes in Europe, a person, for instance, leaving Germany in Spring, and travelling Southward, would have to pass through France and Spain, to the coast of Africa, a journey of about twenty degrees of latitude.

The plain of Amilpas is, to a great extent, covered with volcanic conglomerate, which, in its horizontal strata, forms at some points, such as at *Tepoxtlan*, South of *Cuernavaca*, grotesque groups of rock, and in some places, where the cementing medium has become dissolved, the country is strewn with loose stones. The small mountain streams which flow from the Southern slope of the Popocatepetl, into the plain, have worn deep beds, or ravines, in this deposit of conglomerate, some of which are more than 600 feet in depth. Near the mountain range, from which the water, after heavy rains, rushes down, in innumerable forest streams, these ravines are filled, with incredible rapidity, as high as thirty feet—the torrent uprooting trees, and bearing away rocks, with a thundering noise, and irresistible power. Man and beast fly, with terror, from the impending danger.

Out of this wide-spreading deposit of volcanic conglomerate arise, like islands, isolated hills of basalt, of trachyte, and of a lime-stone formation, which consists of a compact gray lime-stone, containing beds of brown iron ore.

Not far West of the village of *Xonacatapec*, on the Eastern boundary of the valley, lies an interesting group of mountains, consisting of magnetic and brown iron ore, in porphyritic rock, which is partly mixed with hornblende, and, at some points, passes into real *Syenite*. In other parts, it forms a compact mixture of feldspar and garnet ; the latter often appearing in crystals, which are brought to the surface by the decomposition of the feldspar. Vast beds of the purest brown iron ore and magnetic iron ore are found in these mountains, the mining of which has been prosecuted for some years, and the ore extracted, at a furnace situated four leagues distant, Northward from this point.

In one of these beds, at the mine *San Ramon*, the ore on the surface is of the purest brown hematite, which at the depth of, from 20 to 30 feet, passes into magnetic iron ore. Manganese iron ore is frequently found, in company with the brown iron ore. I saw another formation of iron ore, three leagues Eastward of Xonocatepec, beyond the ravine called *Baranca-del-Capon*, in a porphyritic rock, the base of which is clay-stone, of a brownish-greenish color. Extensive veins of magnetic iron ore are found also in this porphyry.

After describing the excursion to the valley of Amilpas, I return to our ascent of the Popocatepetl. The South side of the mountain seemed to be the least difficult to ascend, the upper part being entirely free from snow, but rocky, and covered with ice, up to the very summit. This circumstance, and having learned that some Englishmen had previously made the ascent of the volcano on this side, induced us to take the same route.

In the before-mentioned village of Ozumba, West of the summit of the mountain, we obtained, through the agency of the Alcalde, three Indians as guides, who were provided with axes. We were, besides, accompanied by two dragoons and three of our servants, leading two pack mules, laden with barley, for forage, and our provisions.

Early on the 22d of May, this expedition proceeded in a S. W. direction from Ozumba, to the Indian village *Atlautla*, half a league distant, and from here we began the ascent, through a dense primeval forest. So thick, indeed, did the woods become after having marched for two hours, that the Indians were obliged to clear the way with their axes. Whilst following our narrow path, at the edge of unfathomable precipices, and ravines thickly overgrown with gigantic firs and pines, there alternately appeared and disappeared from our view, the snow-covered peak of the volcano, dazzling in the bright sunlight.

At several steep places, we were obliged to unload the mules, and only with difficulty could we lead our horses. Often it became necessary to aid the Indians in clearing the way through the thicket. We were, however, fully recompensed for our labor by the magnificent view before us. At about noon, we arrived at a herdsman's hut, called the *Rancho-de-Zacapepelo*, where fat cows were grazing in a large meadow of high grass. The calves were fastened near around the hut, for greater protection against the wolves and conguars (the Mexican lion). We found the hut vacant, but, nevertheless, availed ourselves of the fire-place and cooking utensils for preparing dinner.

At this height (11564 Eng. ft. above the sea), the rarefaction of the air became already very perceptible in breathing : the temperature was also much lower. The forest is here less dense, and consists almost entirely of pines (*pinus occidentalis*), here called *Ocote*. Of plants we found the following species (according to Dr. Schiede) : *Oenothera*, *Fuchsia*, *Cineraria*, *Salvia*, *Achyrophorus roseus*, *Chelone gentianoides*, *Amaryllis minuta*, *Phacelia*, *Castilleja*, *Lupinus vaginatus*, and *Eupatorium*.

Leaving a part of our attendants at the hut, where water could be procured for the animals, we resumed our journey, at 4 o'clock in the afternoon, accompanied by two servants and the Indians, carrying jugs of water and provisions. After riding for two hours, through a yielding sandy soil, we reached the limits of vegetation. Here the appearance of every thing changes. On this sandy tract, producing but a little scanty grass, a few ocote trees stand scattered about, their branches drooping to the earth, and green only at the extremities. The above-named *Chelone gentianoides* and *Lupinus vaginatus*, besides some few grasses, still grow at this height. A species of currant, *Tribus odoratum*, is the last plant, and may be regarded as indicating the true limit of vegetation, if we except a mossy plant, *Arenaria bryoides*, which is occasionally found some hundred feet higher.

According to my barometrical measurement, compared with the corresponding observations made in Mexico, the limit of vegetation is 5144 English feet above that city, and 12614 English feet above the level of the sea.

Higher up the mountain, extends a desert of black volcanic sand, strewn with pieces of pumicestone. Of living animals, we saw only a species of small singing birds.

In order to protect ourselves from the cold, which after sundown became quite sensible (5° *Cent.* above freezing point), we kindled a large fire, in front of a fallen tree, which was to afford us shelter for the night, and there prepared our coffee and chocolate. The horses were tied to trees, eating their barley, while shivering with the cold. We hoped the weather would change during the night, and, on the following day, favor our undertaking. But these hopes were soon frustrated. Towards 7 o'clock, heavy storm-laden clouds gathered, and descended from the summit of the volcano, amidst incessant peals of thunder, and discharged themselves with terrific violence. For two hours uninterruptedly, lightning illumined the night. Forks of lightning flashed around, from the clouds above and beneath, crossing each other in every direction; sometimes darting in a horizontal line, and causing us no little alarm. At the same time, a shower of hail and masses of snow fell upon us, against which our only protection was a blanket, fastened at the upper corner to a tree, and the other corners staked to the ground. After the first violence of the storm had passed, as we were wet through and stiff with cold, we endeavored to rekindle our fire, but without success; the snow and rain lasting until 4 o'clock in the morning. At daybreak, we discovered, with dismay, that the whole mountain, to the very top, was covered with snow. Several trees had been struck by lightning, and the sky was still overcast. Notwithstanding that we still decided to persevere in our ascent, it was only with great difficulty, and after many promises of reward, that we succeeded in persuading the Indians to accompany us further. Scarcely had we ridden half an hour in this precipitous ascent, and through the deep sand, now covered with snow, one foot deep, when the horses could proceed no further. We, therefore, sent them back with our servants, and continued the journey on foot, with the Indians. It was a most fatiguing and difficult march, the sand giving way under our feet and causing us to slide back, at every step; besides, the exertion in breathing increased greatly. After a few hours, the Indians complained of weariness, and pain in their feet, caused by walking on the snow; we, therefore, sent them back to a rock, where they promised to await our return. Thus, we were obliged to proceed alone, and leave all our instruments behind, excepting one barometer. In the mean time, the sun had made its appearance, and the rays falling upon the snow, were constantly reflected in our eyes; a circumstance of which we at first took little notice, but which afterwards caused us much suffering. At about 12 o'clock, and after great exertions, we reached a high rock, known under the name of *Pico-del-Fraile* (the Friar's Rock). My barometrical observations indicated, that we were 16870 feet above the level of the sea. The temperature in the shade was 7° above the freezing point.

Having somewhat recovered from fatigue, we examined the way we would have to take in order to reach the summit, and found the only access to be over rugged rocks and across deep chasms, which were now rendered impassable by the snow. It was but too evident that we must abandon our design of ascending the volcano, and more especially so, as daylight would soon fail us; besides, new clouds had commenced to gather around the peak. On our descent we were joined by the guides, and before reaching the limit of vegetation, found our servants, who had come to meet us with the horses, which we rode to the *Rancho-de-Zacapepelo*, arriving at sundown. There, in the hut, stretched before a fire, and having refreshed ourselves with warm coffee and milk, we hoped to pass the night in necessary repose. But very soon, I was awakened by a painful burning in my eyes, and this pain, seated near the optical nerve, became so intense that I was compelled to abandon all idea of rest for the night. My face became very much swollen, and by daybreak, I was unable to open my eyes. My companion fared little better, but finally, by a continued fomenting of our eyes with warm milk, we succeeded in distinguishing daylight, and were enabled, to mount our horses. We proceeded slowly down the mountain, and at 3 o'clock, P. M., reached our quarters at Ozumba, where we rested a day and a half, and then returned to the City of Mexico. It was, however, more than four weeks before our eyes and faces fully recovered from the terrible effects of the snow.

Taught by experience, we resolved, the following year, to renew our attempt to reach the summit of the volcano. Accordingly, we started before the rainy season, on the 28th of April, early in the morning, taking the same road from Ozumba, as before. Three Indians from the village of *Atlautla* again accompanied us, two of whom, the brothers Paez, were of our former expedition. An

English landscape painter, Mr. Fl. Egerton, had joined us from Mexico, and we were provided with every thing which could tend to our comfort and security. Above all, we had procured a spacious tent and several stakes, from twelve to fifteen feet in length, and furnished with iron spikes at the ends—an assistance in mounting which we had greatly missed in the preceding attempt. The plants we had before found (in the month of May) between the village *Atlautla* and the limits of vegetation, and which were now blooming, belong (according to Dr. Schiede) to the following species: three kinds of *Salvia; Baccharis; Cineraria,* four species; *Tlacoxiloxochitl* (according to Hernandez), *Cestrum? Asclepias; Iresinis* sp.; *Ericinea an arbutus? Eupatorium,* two species; *Arbuti* sp.; *Hedyotis cor. coccinea; Viburnium; Cestri* sp.; *Corcopsis; Myosotis,* grandiflora; *Myosotis* fl. albo.; *Stachydis* sp.; *Lobeliae* sp.; *Steviae* sp.; *Leonia salvifolia* (frutex extraordinarius); *Composita; Oenothera,* three species; *Fuchsia; Ignotum genus frutus spectabilis* (like a fern); *Achyrophorus roseus.*

The plants met with at the highest points were *Chelone gentianoides, Amaryllis minuta, Phaceliae* sp., *Castilleja, Lupinus vaginatus, Ribes odoratum, Arenaria bryoides,* which appear beyond the real limit of vegetation.

Towards 3 o'clock, in the afternoon, we reached the limits of vegetation, and there pitched our tent. Whilst the Indians were kindling a fire, we reconnoitred to find the best route on which to proceed early the next morning, by moonlight; and then, having partaken of a light meal, and made our preparations for the following day, we retired for the night.

On the 29th of April, at 2 o'clock, in the morning, and favored by moonlight, we started, but had been riding hardly an hour, when the horses became unable to proceed through the deep sand, and we were almost frozen during the ride. So, we dismounted, and continued on foot, in the direction of the *Pico-del-Fraile*, attended by one servant and the Indians, who carried our instruments. To guard against the penetrating cold, we enveloped ourselves well, and covered our eyes with a green gauze, a precaution which, in the snowy region, saved us from the influences of the glaring reflection of the sun's rays.

The tract between the limits of vegetation and the *Pico-del-Fraile*, has the appearance of an endless waste, covered with pieces of pumice stone, of all dimensions. The sand, seen through a magnifying glass, consists chiefly of black basaltic lava, which the volcano seems to have thrown out with the pumice stone. Occasional rocks, emerging from the sand, are composed of trachyte and porphyry; respecting their transitions, as well as their formation, I can only repeat what I said of the *Peñon-nuevo*, near Mexico.

Owing to the considerable height we had gained, when the sun arose, at 6:30 o'clock, an imposing spectacle presented itself to our view, in the cone-shaped shadow of the mountain, which extended in apparently infinite length towards the West. At 8:30 o'clock, we reached the *Pico-del-Fraile*, a rock 150 feet high, and composed of red alumino porphyry. We here rested for one hour, and refreshed ourselves with a light breakfast. The temperature in the shade was here only $1\frac{1}{2}°$ above the freezing point. When about to continue our journey, the Indians, deaf to all our persuasions and promises, refused to accompany us further, which brought upon us the disagreeable necessity of leaving some of our instruments behind. We were thus deprived of our theodolite (for determining the several azimuth angles, and the local attraction, or deviation, of the magnetic needle from that of Mexico), and an apparatus for boiling water, in order to test its temperature. We could only take with us a hygrometer (of Daniels' invention), a telescope and one of Carry's barometers. The Mexican servant of Mr. Egerton, a boy of 16 years, ventured, however, to follow his master. From the *Pico-del-Fraile* upward, lie a succession of steep rocks, which prevented our proceeding further in this direction. Having changed our course towards the right, or East, we descended into a chasm, situated on the Southern side, and about one thousand feet below the peak of the volcano. Here the water collects, which is constantly producing on this side, by the melting of the snow, and it forms the sources of many small streams, which flow into the valley of Amilpas.

The Eastern side of this chasm is also formed by a ridge of rocks, which extends to the summit of the volcano. The bottom of the chasm is chiefly covered with deep sand, and its inclination towards the horizon is about 35°, by measurement with the sex tant of the hand compass. In but few places did we encounter snow, though we had already reached the height of 2000 feet beyond the limit of perpetual snow. The shifting sand and the great declivity of the surface upon which the snow falls, are probably the causes of this phenomenon, which can scarcely be attributed, either to the internal fire of the volcano, or to the currents of warmer air, on this side of the mountain, coming in immediate contact with the lower air strata, arising from the valley of Amilpas, since the rocks on both sides of the chasm are almost everywhere as completely covered with snow, as the other sides of the cone. After three hours and a half of most wearisome ascent, we reached the limits, or upper end, of the chasm. From here we moved on, through the snow, which, notwithstanding its depth—we sometimes sinking to our waists into it—did not fatigue us as much as the walking through the sand, where our feet slipped back, at every step. On account of the steepness of the acclivity, we first took an easterly, then a westerly course, and, finally, at 2:30 o'clock, P. M., we reached the summit of the mountain.

Until now, we had discovered no trace of a crater, and it was only, when we had gained the highest point, that this unfathomable abyss suddenly yawned before us, striking us with surprise and awe. We were now on the highest edge of the crater, the lower edge inclining towards the East. The mouth has an irregular elliptical form, the long axis of which, lying in a N. W. direction (as measured with the hand compass) is 5000 ft. in length, and the short axis (measured by the eye) is about 4000 ft., making a periphery of more than half a German mile. The inner walls of the crater descend almost perpendicularly, on all sides, to the depth of, from 800 to 1000 ft. The bottom presents a level surface smaller than the opening of the crater, but of similar shape. By the bright sunlight, we could clearly discern two sulphur springs rising at the bottom, in the form of white vapors, which, on descending, deposit sulphur. From this we can form an idea of the temperature which must exist there. The entire bottom, as well as the sides, are covered with sulphur; whence we must conclude that this process has been going on for a long time. I am persuaded that the narrowing of the lower part of the crater proceeds from an accumulation of sulphur, during hundreds of years. On the inner upper surface of the crater, there is no sulphur, but we found the side walls perforated by small round holes, from 1 inch to 3 inches in diameter, from which sulphurous vapors escape, with some noise, and varying force. In order to observe them more closely, I descended 60 feet on the Western side, where there are several ledges, or steps. The rock is here of a compact red porphyry, of a lava-like formation, with a considerable portion of vitreous feldspar. This mass has become quite softened at those points where the vapor issues. The opposite inner walls of the crater seem to consist of a different mass, which when observed, both with the naked eye, and through the telescope, presents a brownish-gray hue, horizontally stratified, and perfectly similar to that which I have described, when speaking of the lava stream in the crater of Ayotla. We could discover no places in the crater, where it would have been possible for us to descend to the bottom, even if such an undertaking had not been otherwise rendered impracticable by the oppression, exhaustion and tension of our blood vessels, especially those of the forehead and eyes, produced by the rarified air, which permitted but a short sojourn at such an elevation. From this we may judge of the truth of a statement, found in the history of the Mexican conquest by Cortez, where it is asserted, that *Francisco Montano*, one of his followers, procured sulphur for making gunpowder, from the crater of the Popocatepetl, into which he caused himself to be lowered by ropes.

Diego de Ordaz, who is said to have been the first who ascended the volcano, was in reward allowed by Charles V., to bear a smoking mountain on his coat of arms. As in our ascent of the mountain, and during the day, we had not seen a living thing, and a grave-like stillness had reigned around us, we were strangely impressed by the sudden noise proceeding from the crater. Stones were continually falling from the side-walls into the precipice, causing a hollow reverberation, and, from time to time, at nearly equal intervals, we heard an underground thundering noise, like a distant discharge of artillery. Such subterranean thunder is often heard at the city of Mexico, in the direction of the Popocatepetl.

In the first volume for 1832, of the *Registro Trimestre*, a paper published here, we find an article by *Dr. Pablo de la Llave* (whose death last year deprived Mexico of one of her most distinguished citizens and scholars), in which he gives all the notes and information he has gathered concerning this subterranean thunder—from which it appears, that they originate in a deep underground laboratory, which extends from here, in the direction of *Orizaba*, to the East coast, at *San Andres-de-Tuxtla* (where not many years since a volcanic eruption had occurred), and probably stretches, on the other side, from here to the West coast, as far as *Acapulco* and *Colima.*

In the range of partly extinguished and partly active volcanoes, which extend from East to West, from one ocean to the other, intersecting the Cordilleras at right angles, the principal peaks are, those of *Tuxtla* and *Orizaba*, on the Eastern slope of the Cordilleras, the Popocatepetl and Iztlaccihuatl, and the *Nevado-de-Toluca*, on the mountain range of the Cordilleras, and on its Western slope, are the volcanoes of *Jorullo* and *Colima.* Only on the supposition that these volcanoes, which are on the surface, connected by a skeleton of volcanic rocks, are also united *under* the surface, by a chain of volcanic elements, in continual activity, we may account for the violent earthquakes which (in the direction mentioned) cause the American continent, from the Gulf of Mexico to the Pacific Ocean, to oscillate at the same time.

One of these earthquakes, which occurred on the 13th of March, 1834, at 10 o'clock, P. M., and the motion of which was at first so violent that one could scarcely maintain an erect position, began gradually, and with certain slow regularity, moving from East to West. Many persons were affected with nausea and dizziness, as on shipboard. These oscillations then gradually decreased. The whole duration of the earthquake was about from 3½ to 4 minutes.

Many arches of the aqueducts which lead to the city, in the direction from West to East, were rent asunder, to such an extent, that the water burst through, in many parts. Of the arches spanning from North to South, none were injured. Many other structures were damaged.

According to the accounts which I collected, the same effects were perceived, at the same time, in *Vera-Cruz*, *San Andres*, *Huatusco*, *Jalapa*, and *Puebla*. Huatusco lies between the volcanoes *Tuxtla* and *Orizaba;* three leagues further North from it, scarcely any motion was felt. At a few miles North and South of Mexico, the shock was hardly perceptible ; but, on the other hand, it was felt in the district of *Morelia*, in the direction of the above described line of volcanoes, and towards *Acapulco*, where it became so violent that many buildings were demolished, and a high surge was occasioned at sea. On the 15th of March, at 6 o'clock in the morning, a second similar earthquake was felt, as strong as the first, but of shorter duration. The oscillation was, this time, from S.E. to N.W., and continued only 2½ minutes. It was also felt in *Vera-Cruz*, *Acapulco*, and *Valladolid*. Some days later, several more, though inconsiderable, shocks occurred. They took place on the 21st of March, at about 7:30 o'clock, in the morning, with oscillations between East and West ; and on the 22d of the same month, at 11 h. 10 m. in the morning, moving from N. E. to S. W.

By means of a glass ball, which was suspended in my room by a long chain, I could observe the directions of the oscillations quite accurately. From their commencement until they ceased, they diverged 40° from the above-stated direction. During none of the earthquakes, were any extraordinary meteoric phenomena observed. The barometer showed no unusual deviation from its daily range, and no subterranean thunder was heard in the city of Mexico. The ingenious hypothesis advanced by A. v. Humboldt, in describing the origin of the volcano Jorullo, in the year

1759—(Essai politique, Tome II. Livre III. chapter VIII. page 174), acquires great probability by all these later observations. He states, namely, that between the latitudes of 18° 59′ and 19° 12′, within which all the above-named volcanic mountains are situated, the earth, at a great depth, has a rent, or cleft, running from East to West, through which, at different periods and at different places, extending from the Gulf of Mexico to the Pacific Ocean, and still further on, to the island groups of *Revillagigedo*, the volcanic fires broke through the surface of the earth and formed these mountains.

From the summit of the Popocatapetl, we overlooked a vast horizon, extending nearly from the Atlantic, to the Pacific Ocean. To the East, we had the heights of the *Pic-de-Orizaba*, and of the *Cofre-de-Perote*; at the Southern foot of the mountain, the valley of *Amilpas*; westwardly, the mountains of *Ajusco*, the elevated plain of *Toluca*, with its grand snow-capped chain of the *Nevado-de-Toluca;* finally, between East and West, in the States of *Oaxaca*, *Mexico*, and *Michoacan*, the peaks of the *Sierra-Madre*, extending toward the North and Northwest, lay the Valley of Mexico, in the background of which we could distinguish the mining districts of *Pachuca*, *Real-del-Monte*, *Atotonilco-el-Chico*, *Zimapan*, *San Jose-del-Oro*, *El Doctor*, and, at a greater distance and less distinctly, appeared that of *Guanajuato*. At our feet, lay the volcano Iztlaccihuatl, the crater of which was, however, hidden from view.

On beholding this immense panorama, where at a glance I could recognize all the districts which I had previously traversed, and the geognosy of which I had studied, I became convinced that the Popocatepetl, as well as the whole highlands of Mexico, had been formed by volcanic revolutions; and that the fluid mass thrown up from the earth, forcing its way through the existing primitive and transition rocks, had raised itself to its present height, covering and modifying the surface.

The many mining districts which I had visited, in the States of Puebla, Mexico, and Michoacan, and whose rich beds of ore, occurring, partly in the slate, and partly in the porphyritic formation, appear to be small remains and insular points which have been spared from this general volcanic cataclysm, and, remaining in their primitive state, are thus saved for mining purposes. My desire to make the most accurate measurement possible of Popocatepetl, by means of a precise reading of the height of the mercurial column, by comparing the same with simultaneous observations in Mexico, was cut short in its fulfilment, in consequence of the air having entered the tube of the barometer, while discharging the superfluous mercury, despite all precautions, and it being impossible for me to restore the instrument to a serviceable condition. For all similar observations, I would now prefer a good syphon barometer (Heber-barometer) to any mountain barometer, because no mercury need be taken out, and also on account of its being less heavy. As A. von Humboldt has measured the height of Popocatepetl with great accuracy,* aided by geodetic measurements from the plateau of Mexico, and established the same to be 3123 metres, the difference which may result in comparing future computations of exact barometrical observations with this standard result, might furnish the means to control and, perhaps, to correct the barometrical formulas. For this purpose, I here communicate the observations made by an Englishman, Mr. N. Berkbeck, who ascended to the summit of the volcano, on the 10th of November 1827, at 3 o'clock, in the afternoon. He observed the height of the column of mercury in his barometer (probably a so-called mountain barometer) to be 15.616 inches, at a temperature of 22° Fahrenheit. The corresponding observations of the barometer and thermometer at Mexico, are stated to be 23.002 inches, at a temperature of 72° Fahrenheit of the mercury, and 74° in the air.

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* A. von Humboldt's altitude of Popocatepetl has not been computed with reference to the altitude of the City of Mexico. The trigonometrical survey, for this purpose, was not conducted in the valley of Mexico, but upon the *Llano-de-Tetimba*, near *San Nicholas-de-los-Rancheros*, and East of the city of Cholula. It was here, where he measured a base line of 2,799 feet.—*Rec. d' Obsero. astr.*, V. II., p. 543.

By the formula of Maskelyne, he has calculated the height of Popocatepetl to be 10382.5 English feet above Mexico. According to Humboldt, this height is 10245.9 English feet; difference, 136.6 English feet.

The height of Mexico above Vera-Cruz, has been established by Humboldt at 2277 metres, or 7470.38 English feet, by barometrical measurement. Thus, the whole height of Popocatepetl, above the sea, at Vera-Cruz, would be 17852.88 English feet.

Mr. Wm. Glennie, a scientifically educated gentleman, in the service of the English mining company, first ascended the volcano, on the 20th April, 1827. His barometrical observations are not known to me, but he calculated the height of Popocatepetl to be 17884 English feet, wherein he has probably included the height of Mexico, above Vera-Cruz, as given by Humboldt.

After the deduction of the same, there remain, according to Mr. Glennie, 10413.6 English feet for its height above Mexico, being 168.7 feet more than the geodetic measurement of Humboldt.

The before stated height of Mexico, above the level of the sea at Vera-Cruz, may be recalculated by comparing the normal height of Mexico, as I have already stated it:—at 0.58847 metres, at 21° 06 Cent. temperature of the mercury, 19° 92 Cent. temperature of the air, with the mean of the observations, which in the year 1830, were made at Vera-Cruz, with an English mountain barometer—these daily observations having been taken throughout the whole year. According to these observations (published in the journal *El Faro*, No. 151, of the 3d of January, 1831), wherein the highest and lowest points of the barometer are given, the mean height of the barometer is 30.20 English inches, or 0.7671 *metres*, and the mean of the temperature 25° Cent.

By fifty-two observations, made by Dr. Schiede at Vera-Cruz, in 1828, with a good syphon-barometer, from Paris, the mean of the barometer and of the temperature is found to be 0.7650 metres and 29° Cent. Calculating, then, from these data, we obtain (by means of the tables derived by Maskelyne's formula, and published by Thomas Jones, in London) 7548.5 and 7532 English feet, which heights are both greater than that determined by A. von Humboldt, as 7470 English feet, the positive height of Mexico.*

At about 4 o'clock, after we had raised a large flag, which Baron Gros had brought with him for the purpose, fastened it to a pole twenty feet long, and planted it on the outer edge of the peak, we began our descent, and by sundown, reached our tent in safety. Here we passed the night, and on the following day, travelling *via* Ozumba and Ameca, arrived in Mexico.

To conclude, I give here some of the physical observations made during our ascent of the volcano:

1. At the limit of vegetation, at about 6 o'clock, P. M., the *precipitation* (on the Daniels-hygrometer) took place at 36½° of Fahrenheit's thermometer, and 50° Fahrenheit being the temperature of the external air. Water boiled at 90° Centigrade. The barometer (at 6 o'clock P. M.) marked 19.120 English inches, by 9° Cent.

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* The differences between the altitudes of the city of Mexico, as given by Humboldt's and Gerolt's observations, amount to 70 English feet, or $\frac{1}{107}$; but their respective computations were based upon different formulas.

Former observations, computed by Laplace, have been published by Oltman (Part I. page 5). They differ from 1155 to 1175 toises.

temperature; the corresponding observations at Mexico, were 23.071 inches, by 22° Cent. temperature. Whence the height above Mexico, results to be 5144 English feet.

2. At the Pico-del-Fraile, at about 9 o'clock, in the morning, water boiled at 82° Centigrade. My barometrical observations on the 23d May, of the year previous, was here 16.468 English inches, by 9° Centigrade temperature, and the corresponding points at Mexico, were 23.102 inches, and 24° Centigrade; whence the height is 9400 English feet above Mexico.

3. An observation with the hygrometer on the peak of Popocatepetl, gave 33½° Fahrenheit, of the inner thermometer, and 41° of the external air at the moment of precipitation.*

4. The calculated height of the village of Ozumba, taken at its market-place, is 7874 English feet, and that of Ameca, also at its market-place, is 8246 English feet above the level of the sea.

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* Some derangement of the barometer on the summit of the Popocatepetl, prevented me from taking an exact reading of the mercury column, which was about 15 inches.

TABLE OF BAROMETRICAL OBSERVATIONS MADE AT THE CITY OF MEXICO, *from the month of March*, 1833, *to March*, 1834, *inclusive.*

Time of Observation.			Absolute height of the Mercurial Column.		Temperature of Mercury.	Temperature of Atmospheric Air.	Observations.	Average of the regular daily periodical height of the Mercury		Average Temperature.	
Month.	Day.	Hour.	Highest.	Lowest.				Highest 9 to 10 a.m.	Lowest 3 p. m.	Of the Mercury.	Of the Atmospheric Air.
1833.			METRES.	METRES.							
March	9	8 a. m.	0.5913		20	12	Cloudy,	0.5887		20.58	16.62
	29	3 p. m.		0.5830	24	24½	Single clouds, windy,		0.5856	22.04	23.80
April	20	7 a. m.	0.5911		23½	15	Clear,	0.5889		22.50	19.54
	26	4½ p. m.		0.5846	24	23½	Cloudy, windy,		0.5864	23.50	23.58
							First quarter 10 h. 57′ p. m.,				
May..............	7	4¾ p. m.		0.5862	23	22	Single clouds,	0.5896		22.41	20.91
	15	9¾ a. m.	0.5912		22½	23½			0.5867	23.40	24.45
June..............	6	3½ p. m.		0.5859	25	22	Rain,	0.5894		24.45	20.57
	22	9½ a. m.	0.5907		25	22	Clear,		0.5871	24.64	23.87
July..............	15	8½ a. m.	0.5927		23	19	Clear,	0.5909		22.14	20.10
	30	3¾ p. m.		0.5880	22	21	Cloudy, thunder,		0.5889	22.65	23.78
August............	3	8½ a. m.	0.5916		21	14	Cloudy,	0.5898		21.50	18.64
	15	5½ p. m.		0.5861	21½	21	Cloudy, thunder,		0.5875	22.04	22.78
							New moon, 7 h. 59′ a. m.,				
September	7	3½ p. m.		0.5858	22½	26	Single clouds,	0.5891		20.24	18.50
	21	9 a. m.	0.5910		22½	20	Clear,		0.5866	21.96	24.32
October...........	10	3½ p. m.		0.5857	22½	22½	Cloudy,	0.5902		20.21	17.21
	18	8¾ a. m.	0.5920		19½	14	Cloudy,		0.5872	21.55	22.16
November.........	7	3 p. m.		0.5845	21	22	Clear,	0.5899		18.37	14.62
	21	9½ a. m.	0.5931		18	13	Clear,		0.5872	19.43	20.05
December	8	9 a. m.	0.5911		19	13	Cloudy,	0.5898		18.12	13.87
	11	3½ p. m.		0.5852	20	20	Clear,		0.5867	19.34	19.94
							New moon, 0 h. 35′ a. m.,				
1834.											
January	2	3½ p. m.		0.5844	18½	19	Clear, windy,	0.5907		17.48	13.24
	23	9¾ a. m.	0.5925		18	14	Last quarter, 9 h. 32′ a. m.				
							Cloudy,		0.5875	19.32	20.62
February..........	4	9 a. m.	0.5921		18	14	Single clouds,	0.5906		18.37	15.08
	15	4 p. m.		0.5847	19	19	Clear, windy,		0.5873	19.61	20.79
March.............	1	4 p. m.		0.5858	22	24	Clear,	0.5902		20.17	16.65
	4	9 a. m.	0.5929		20	12	Clear,		0.5878	21.62	22.75

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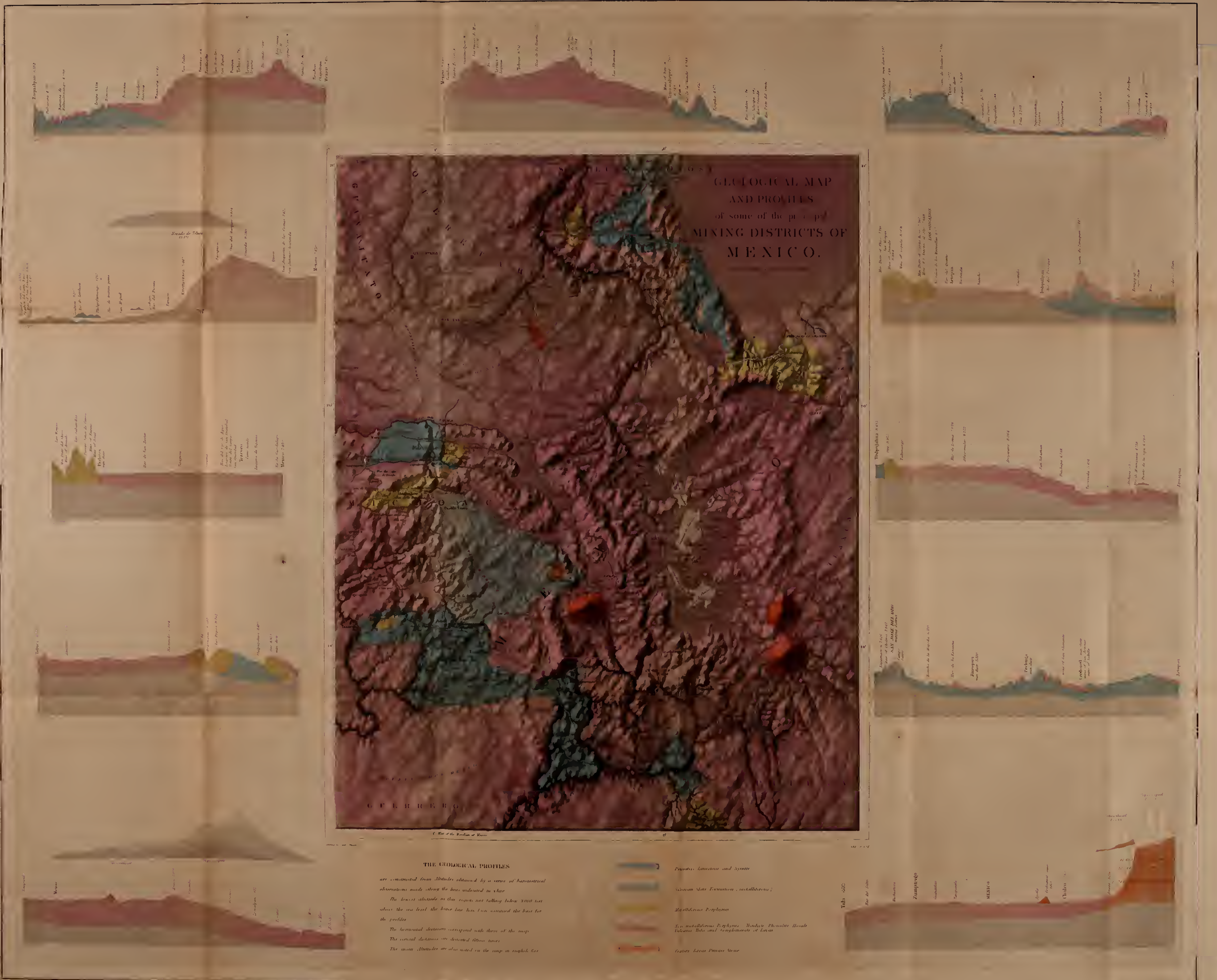


GEOLOGICAL MAP AND PROFILES
of some of the principal
MINING DISTRICTS OF MEXICO.

THE GEOLOGICAL PROFILES

are constructed from Altitudes obtained by a series of barometrical observations made along the lines indicated in blue.

The lowest altitude in this region not falling below 3000 feet above the sea level, the base line has been assumed the base for the profiles.

The horizontal distances correspond with those of the map.

The vertical distances are denoted fifteen times.

The main Altitudes are also noted on the map in english feet.

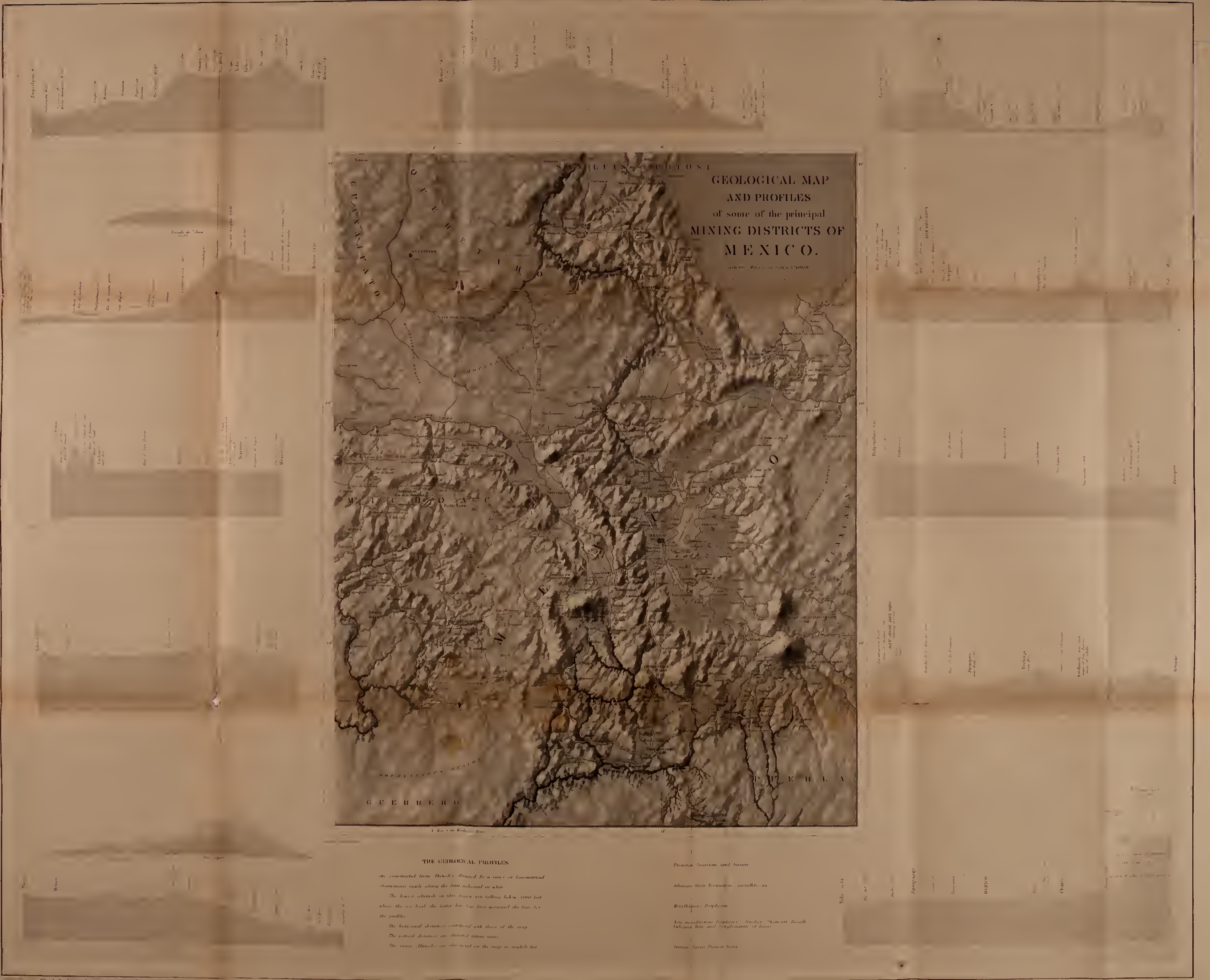
Primitive Limestone and Syenite

Silurian Slate Formation (metalliferous)

Metalliferous Porphyries

Non metalliferous Porphyries, Trachyte, Phonolite, Basalt, Volcanic Tufa and Conglomerate of Lavas

Craters, Lavas, Pumice Stone



GEOLOGICAL MAP
AND PROFILES
# of some of the principal
MINING DISTRICTS OF
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THE GEOLOGICAL PROFILES

are constructed from altitudes obtained by a series of barometrical observations made along the lines indicated in white.

The lowest altitude in this region not falling below 3000 feet above the sea level, the latter line has been assumed the base for the profiles.

The horizontal distances correspond with those of the map.

The vertical distances are distorted fifteen times.

The main Altitudes are also noted on the map in english feet.

Primitive Limestone and Syenite

Silurian Slate Formation, metalliferous

Metalliferous Porphyries

Non metalliferous Porphyries, Trachyte, Phonolite, Basalt, Volcanic Tufa and Conglomerate of Lavas

Craters, Lavas, Pumice Stone